

Talking Trash:

A large pile of trash, including plastic bags, wood, and other debris, is shown in the foreground. In the background, a yellow bulldozer is visible, and several birds are flying in the sky.

“Did you know that the average person produces three pounds of garbage a day?” a woman asks her therapist at the start of the 1989 movie *Sex, Lies, and Videotape*. “I’d really like to know where it’s all going to go.” The movie’s opening joke seems prescient now that the per-capita figure for waste produced has topped four pounds per person per day. In 1994 (the most recent year for which detailed data are available), over 306 million tons of municipal solid waste (MSW)—mainly household waste, lawn clippings, and light construction debris—was generated in the United States, and the amount is increasing at roughly 5% annually, according to Resources for the Future (RFF), a Washington, DC-based public interest group.

In 1988, the U.S. Environmental Protection Agency (EPA) instituted the first federal standards for landfills through Subtitle D, an amendment to the Resource Conservation and Recovery Act. Subtitle D

national trend toward megafills that can handle 5,000–10,000 tons a day. In the past, MSW was dispatched to the nearest local landfill or incinerator, but because the larger fills have become cheaper than incineration in the past five years, most solid waste now goes to them. The solid waste disposal industry has grown to \$35 billion annually, according to an article in the 20 January 1999 online issue of *Inside Business*.

Contrary to public perception that smaller means less dangerous due to a lower concentration of toxicants, the large Subtitle D landfills are actually safer than pre-1988 landfills because they must meet federal requirements for preventing air and water pollution and for limiting the spread of disease by scavengers. However, the new landfills have their own set of environmental hazards and are the topic of some debate. Because the logistics and costs of landfill management are beyond the means of most municipalities, the new landfills

air from the landfills as organic matter decomposes, is especially suspected of causing such problems. A Canadian study by Mark S. Goldberg and fellow researchers with the Montreal Health Department, published in the November/December 1995 issue of the *Archives of Environmental Health*, looked at neighborhoods near an MSW landfill in Montreal. The study showed high rates of stomach and cervical cancer among women living near the landfill and a higher than expected incidence of stomach, liver, and prostate cancer in men. Concentrations of up to 25 parts per million of gases, particularly methane and the known carcinogens benzene and vinyl chloride, were recorded on streets near the landfill. The potential health risk presented by pre-Subtitle D landfills is often overlooked, according to Garcia. Although closed, many older landfills still produce methane gas. “And if the methane is moving laterally, as it has a habit of doing, it can be getting into nearby houses,” she says.

The Economic and Environmental Issues of Landfills

outlines construction and operation requirements for all landfills built after 1988 that allow them to better protect groundwater and air quality. As a result of these new requirements, the fixed costs of running a landfill—installing and maintaining pit liners and monitoring wells, and providing additional training for landfill operators—have risen dramatically. In order to be economical, landfill operators must distribute these costs over a larger client base by taking in a larger volume of solid waste.

Since 1988, the number of landfills in the United States has shifted from over 10,000 small municipal landfills to an estimated 3,500 newer landfills, known as Subtitle D landfills. The largest of these landfills are known as “megafills.” Such landfills may take in waste from an area extended beyond local and even state boundaries. For example, seven megafills in Virginia take in up to 6,000 tons of solid waste a day, much of it from other states, and have total capacities of up to 140 million cubic yards and reach heights of up to 550 feet. Brian Guzzone, technical divisions manager for the Solid Waste Association of North America, sees a

are economically feasible only for contractors or large cities. This has led to the creation of megafills and a large interstate traffic in MSW.

The current controversy involves a negative public perception of state imports of garbage, environmental justice issues over placement of megafills (they are usually sited in poorer counties), and concerns about air, water, and noise pollution generated by both the transport of MSW and the landfills themselves. “That’s the dilemma,” says Margot Garcia, a professor of urban planning at Virginia Commonwealth University in Richmond. “To get rid of the old landfill risks, new regulations were put forth that led to larger landfills, and now people aren’t happy about those.”

Risks of the Old

Research has linked exposure to air and water pollution from some old-style landfills to human health problems such as developmental abnormalities, low birth weights, and cancer. Exposure to methane and other gases, which are released into the

Groundwater contamination poses the other main risk of older landfills. With no liners, chemicals from

discarded items such as batteries, paints, and cleaners can leach directly into underground aquifers used for drinking water. For example, water samples taken down-slope of a municipal landfill in Norman, Oklahoma, that was closed in 1985 revealed significant levels of benzene, toluene, and vinyl chloride. In a study by M. A. Bruner and colleagues at Oklahoma State University in Stillwater, published in the March 1998 issue of *Ecotoxicology and Environmental Safety*, recorded levels of these chemicals were found to be significant enough to cause abnormalities and death in amphibian embryos, although whether the toxicants posed a danger to humans in the area could not be confirmed. Concerns about leachate from older landfills are compounded by the difficulty of knowing what the fills contain, because many had weak restrictions on the types of things that could be dumped. Not knowing what landfills contain makes it difficult to know what types of toxicants to test for and what types of interactions may occur between different materials.

According to an article by N. E. Ortiz and G. R. Smith published in the April 1994 issue of *Epidemiology and Infection*, uncovered landfills can be a major source of biological contaminants such as *Clostridium botulinum* (the bacterium that causes botulism), which can be carried by seagulls and other scavengers who feed at landfills. The practice of covering fills with a layer of dirt each night, which is required of newer landfills, has helped to reduce this threat.

Newer Landfills

Experts recognize that Subtitle D landfills are substantially safer than older landfills. Today's landfills accept only certain kinds of waste. Occasionally, hazardous materials arrive at landfills. For example, in February, Virginia state inspectors discovered medical waste, including needles and syringes, at a landfill southeast of Richmond. This is relatively rare, however, and when it does occur, such materials are sent to separate, specialized facilities that handle those types of waste. Compliance with federal landfill regulations is monitored in most states by state inspectors.

The removal of methane by piping the gas to on-site recovery systems has reduced the risk to nearby communities of exposure to the airborne toxicant. Landfill operators are able to track methane gas movement fairly well in any modern landfill, says Garcia, and landfills are now required by Subtitle D to be equipped with suction systems that remove the gas safely.

With the passage of landfill operator certification laws in a number of states, landfill workers are required to be better prepared for problems such as hazardous materials or leakage. Subtitle D restricts the placement of landfill sites to avoid environmental damage or human health

risk. For example, landfills cannot be placed close to airports (where the seagulls and other scavenger birds they attract would present a hazard for air traffic), in critical wetlands, near earthquake faults, or in areas prone to flooding.

Perhaps the greatest safety improvement is in the area of groundwater. To protect groundwater, Subtitle D requires landfills to have liners of composite plastic sheeting that is slightly thicker than the cardboard on the back of a legal pad topped with a two-foot layer of compacted soil. Monitoring wells are required around landfill sites to check for leachate passing through the liners into groundwater. The wells must be checked for groundwater contaminants at least semiannually while a landfill is in operation and for 30 years after it has reached capacity and been sealed with an impermeable cap. To provide for these postclosure monitoring costs, landfill owners must contribute a portion of tipping fees (the per-ton charge paid to unload a truck at a landfill) to a trust fund that is managed by each state. Subtitle D also requires leachate removal systems and specifies that wastes should be covered nightly (usually with a layer of soil) to prevent scavenging.

It is too early to know how well the requirements of Subtitle D are protecting human and environmental health. The EPA has conducted no risk assessment studies of landfills since the 1988 regulations were enacted. At that time, the agency's risk assessment "showed extremely low risk from groundwater contamination," according to Bob Dellinger, director of the EPA's Municipal and Industrial Solid Waste Division. There have been no reported failures of an MSW landfill under the new rules.

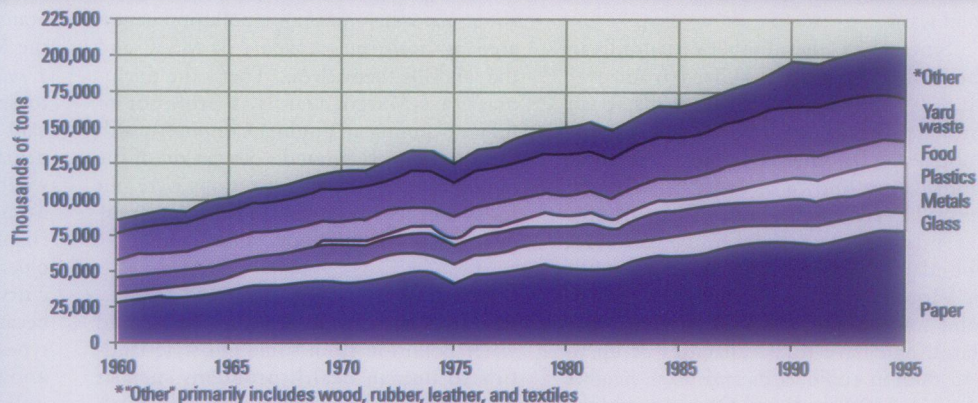
Still, some experts are skeptical of the EPA's assessment that Subtitle D landfills

will reliably protect groundwater. G. Fred Lee, a former professor of groundwater quality studies at the University of Wisconsin at Madison who conducted extensive research on liners, believes that the EPA failed to adequately model the risk of liner failure over time. Lee says that all liners eventually fail and that the monitoring procedures under Subtitle D are faulty because they assume that the layout of wells designed to test unlined landfills will work for lined landfills as well. According to Lee, the two types of landfills leak differently: older, unlined landfills leak more consistently across the whole bottom of the fill, whereas lined landfills leak through individual punctures in the plastic liner. Such individual leaks are unlikely to be detected by a monitoring well, which samples only from the small area of earth around itself, says Lee. He argues that a better guarantee of protection would come from the use of two layers of composite liners with a leak detection system between the two to signal when the upper liner has failed. Such a detection system is already required in Michigan under state law.

Economics: The Bottom Liner?

A major effect of Subtitle D is the trend toward larger landfills, which come with a larger price tag. "The price of these new environmental safeguards is a much more expensive landfill," said Timothy Hayes, a waste industry lawyer in Richmond, in a 16 December 1998 interview with National Public Radio. Because a megafill's customer base may extend over several states, there can be a big financial bonus to the locality that chooses to host a megafill and in return receive a portion of tipping fees. However, megafills come with their own set of environmental problems, and the issue of economic benefits versus environmental trade-

Generation of Materials in Municipal Solid Waste, 1960-1995



Source: U.S. EPA. Characterization of municipal solid waste in the United States, 1996 update. EPA 530-R-97-015. Washington, DC:Environmental Protection Agency, 1997/48.

offs is hotly debated. For example, in King and Queen County, Virginia, county executives decided that the economic benefits of a large private landfill would offset the nuisances of additional traffic and noise it presented. As a result, says county board chairman Robert Rogers, "We built the new courthouse, a new administration building, and have been able to increase the budget for our schools. It's just been a big, big blessing." In Charles City County, Virginia, tipping fees from the megafill operated there contribute an amount equal to nearly a third of the county's total operating budget, according to *Inside Business*.

But county residents who live near the new landfills are concerned about more than money. To them, megafills also bring noise, odors, pests, and dangerous truck traffic. The megafill in King and Queen County has drawn protests from parishioners at the nearby Second Mount Olive Baptist Church. In the December interview with National Public Radio, church deacon Parnell Byrd said that since the 400-acre landfill opened, church picnics and outings have become unsafe because there are "so many seagulls and buzzards flying overhead, bringing trash from the landfill and dropping it all over the place." Odor is another factor that residents who live near landfills say they must contend with, although few data exist on landfill odor levels.

The increase in truck traffic that comes with larger landfills raises concerns on many levels. Residents feel that the trucks are unsafe. Says Castella Jones, who lives near the Second Mount Olive Baptist Church, "We have older people in the community and they're almost afraid to travel the road." Garcia says that truck traffic may be one of the biggest effects felt by communities near the new landfills. "Some communities get 60, 80, 100 [trucks] a day," she says. There are also concerns that the increased truck traffic contributes to air pollution near landfills and to an increased risk of traffic accidents, which may result in waste spills and contamination. These same concerns are voiced about the increased barge traffic that results from increased interstate transport of MSW.

In general, railroads, trucks, and barges all can be made adequately safe for transporting municipal waste, according to various experts, and few experts consider transport of MSW to be risky if it is properly regulated. However, in February 1999, eight states—Virginia, New York, New Jersey, Pennsylvania, West Virginia, Maryland, Ohio, and Delaware—and the District of Columbia mounted a concerted three-day crackdown on trash trucks, dubbed "Trashnet," that resulted in over

	Thousands of tons	Percent of total
Yard trimmings	29,750	14.3
Corrugated boxes	28,800	13.8
Food wastes	14,020	6.7
Newspapers	13,130	6.3
Miscellaneous durables	12,030	5.8
Wood packaging	10,590	5.1
Furniture and furnishings	7,160	3.4
Other commercial printing	7,110	3.4
Office-type paper	6,800	3.3
Paper folding cartons	5,310	2.6
Glass beer and soft drink bottles	5,120	2.5
Clothing and footwear	5,070	2.4
Glass food and other bottles	4,620	2.2
Third-class mail	4,620	2.2
Other nonpackaging paper	3,800	1.8
Rubber tires	3,770	1.8
Major appliances	3,420	1.6
Miscellaneous nondurables	3,320	1.6
Miscellaneous inorganic wastes	3,150	1.5
Disposable diapers	2,960	1.4
Tissue paper and towels	2,950	1.4
Steel cans and other packaging	2,850	1.4
Magazines	2,370	1.1
Other plastic packaging	2,270	1.1
Carpets and rugs	2,230	1.1
Paper bags and sacks	1,990	1.0
Aluminum cans and other packaging	1,970	0.9
Lead-acid batteries	1,910	0.9
Glass wine and liquor bottles	1,780	0.9
Plastic wraps	1,720	0.8
Other plastic containers	1,250	0.6
Plastic bags and sacks	1,170	0.6
Books	1,170	0.6
Other paper packaging	1,120	0.5
Paper plates and cups	970	0.5
Plastic plates and cups	790	0.4
Trash bags	750	0.4
Towels, sheets, and pillowcases	740	0.4
Small appliances	710	0.3
Plastic soft drink bottles	660	0.3
Plastic milk bottles	640	0.3
Paper milk cartons	510	0.2
Telephone directories	490	0.2
Other paperboard packaging	260	0.1
Other miscellaneous packaging	160	0.1
Paper wraps	70	<0.1
Total MSW Generation	208,050	100.0

Source: U.S. EPA. Characterization of municipal solid waste in the United States, 1996 update. EPA 530-R-97-015. Washington, DC:Environmental Protection Agency, 1997:147.

4,000 violation notices. Violations ranged from trucks not being properly covered and waste leakage to incorrect signage and lack of a fire extinguisher.

Some experts say barge traffic doesn't appear any riskier than truck traffic and may produce lower air emissions than trucking. Barge opponents don't agree. "It's a matter of scale," says Glenn Besa, director of the Sierra Club's Virginia Chapter. Although barges would probably mean fewer accidents per trip, he says, the sinking of one barge carrying more than 300 containers of waste would represent a bigger environmental disaster—and one that would be harder to contain in a vul-

nerable ecological system—than a truck accident involving one load of garbage.

Interstate MSW traffic is protected as interstate commerce and subject only to the usual trucking regulations under the Federal Highway Administration. Some experts fear that the resultant lack of state accountability for transport safety will cause interstate turmoil in the event of an accident.

Interstate Issues

Most states now routinely import and export some solid waste, but the issue is still a contentious one. Earlier this year, interstate trade in municipal waste caused a pub-

lic flap between New York City and Virginia, which has become the second largest importer of trash after Pennsylvania. Virginia's governor, James Gilmore, expressed concern that the state risked becoming a "dumping ground" for other states' waste. Concerns about the environmental and health effects of landfills and transport of MSW, coupled with a disturbing perception that the state was prostituting itself to take other states' trash, led Gilmore to order a moratorium on further landfill construction in Virginia in November 1998 and to make solid waste regulation a top priority for the state legislature's recent session. In March 1999, new laws were passed in Virginia that ban garbage barges from state waterways, restrict landfill construction, and limit the amount of MSW dumped at Virginia's seven megafills. In late June, however, a federal judge blocked enforcement of Virginia's new curbs on MSW imports, saying they were clearly violations of the constitutional protection of interstate commerce.

Some research suggests that policies restricting interstate trade in MSW do not necessarily guarantee safer waste disposal or greater economic good. A 10 December 1998 discussion paper by the RFF titled *Spatially and Intertemporally Efficient Waste Management: The*

Costs of Interstate Flow Control describes the results of modeling several scenarios to test the effect of import controls on state and local economies. The scenarios ranged from an outright ban on trash imports to restrictions on import volumes, surcharges on waste imports, and a combination of surcharges and volume restrictions. The models did not account for noneconomic benefits that might result from import restrictions, such as reduced truck traffic and noise levels. The study found that policies designed to restrict interstate waste shipments with import surcharges or volume restrictions actually "reduce aggregate social welfare" by causing more costs to government through monitoring exports and import volumes and by creating a less efficient traffic flow of MSW trucks and barges. Some restrictions could backfire and increase the total number of interstate waste shipments, because states would maneuver to comply with individual states' per-load volume limits. While unrestricted trade may be a greater economic good for society

as a whole, the paper states, some geographic areas and consumers could bear the brunt of that trade.

This introduces a larger issue. There is often a discrepancy between the perspective of individual counties and their governing officials, who may view the trade-off between revenue and environmental health as a risk they are willing to take, and that of state governments and officials, who may object to trash imports. State leaders may remain unconvinced of landfill benefits if all the benefits from tipping fees go to the counties, with the state left to address the issue of waste caravans on highways and waterways. Then there is the issue of who will be responsible if accidents occur and for the eventual cleanup of a landfill site once it can no longer be used. "The question is, who's going to clean up a megafill



Trash mountain. Landfills such as this one, located near the Delaware River in Bucks County, Pennsylvania, can cover hundreds of acres and take in thousands of tons of waste each day.
Source: Zero Waste America (<http://zerowasteamerica.org>)

when it leaks 30 years down the line?" says Besa. "Citizens of Virginia, not the county, are going to be stuck with the bill." Besa says this inequity can be partially solved with a state plan for solid waste management. So far, Virginia has no such plan and decisions are made county by county.

The public confusion over the environmental risks and economic trade-offs of landfills suggests the need for better public education efforts on these issues. Rich Collins, director of the University of Virginia's Institute for Environmental Negotiation in Charlottesville, says that localities have the power to decide their fate. "If a county wants to have a landfill or not," he says, "they can make it clear through their land-use regulations," as these are enacted by elected officials who presumably have a sense of the local consensus.

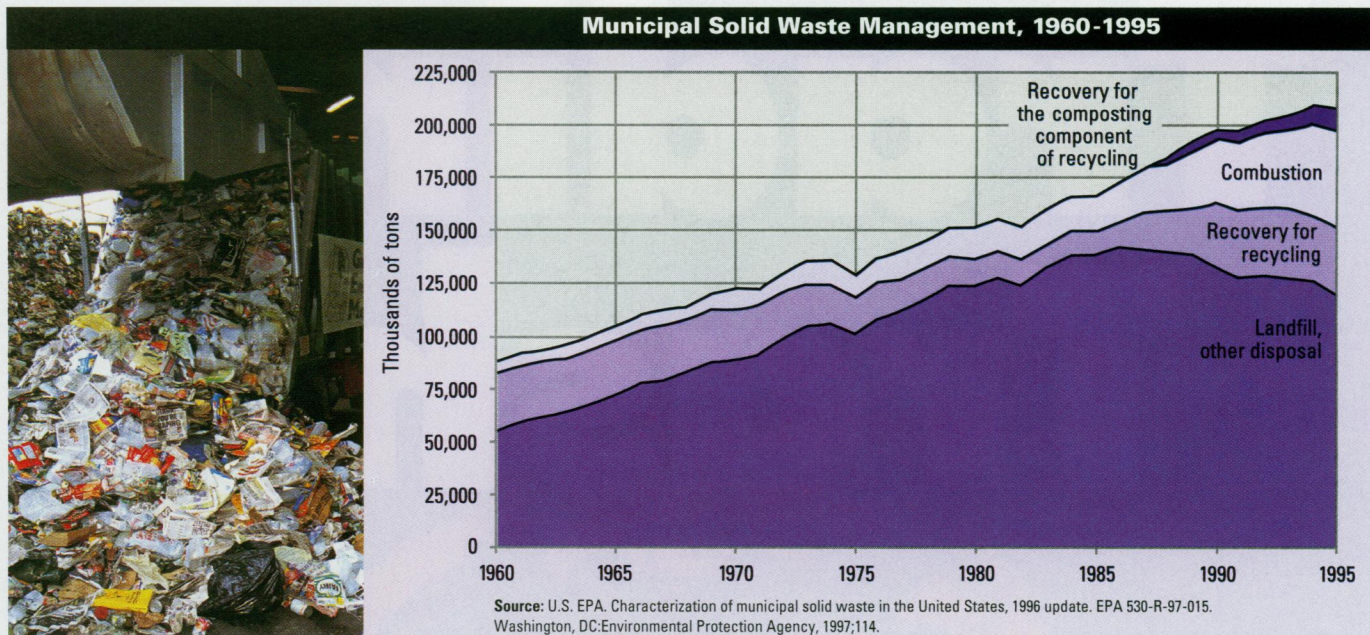
For such decisions, local leaders need good information on the environmental and legal considerations that must be weighed. In part, they can rely on the state for technical expertise. Other resources,

including a number of World Wide Web sites, also provide reliable information. For example, the Local Government Environmental Assistance Network (<http://www.lgean.org>) provides information on environmental management, planning, and regulatory requirements geared for local governments.

Even when counties have the information and authority to decide for themselves whether to allow landfills, economic disparities among citizens raise the issue of environmental justice. For example, most of Virginia's seven megafills are in rural counties with low average family incomes. The revenue from landfills can help poor counties provide services and an infrastructure that they otherwise could not afford, given their tax base. For example, the new courthouse building in King and Queen County (the population of which is nearly half African American) was paid for partly by landfill revenue. Larry Land, director of policy development with the Virginia Association of Counties, wrote in an online article posted earlier in 1999 on the Capitol Connections Web site (<http://www.capitolconnections.com>) that poor counties have built new schools and improved water treatment and other facilities with the revenue from landfills. "The welfare of these counties

must not be ignored," Land noted, "nor should these counties be penalized by unfair rule changes."

At the same time, solid waste companies have been charged with using race and income as factors in identifying facility sites, counting on the probability that poor, disadvantaged communities would lack access to information on long-term health risks, economic consequences, and appropriate compensation. For example, according to an article in the July/August 1998 issue of *E/The Environmental Magazine*, the town of Chester, Pennsylvania, which is more than 60% African American, has attracted a disproportionate number of waste treatment facilities, including a sewage treatment plant and the fourth largest solid waste incinerator in the country. Residents allege that this aggregate concentration of waste is unhealthy and is a result of corrupt local politicians, discriminatory decisions by companies, and the state's failure to prevent such discrimination. In 1996, residents responded to a proposal for another



waste processing facility with a federal suit against Pennsylvania's Department of Environmental Protection, invoking the 1964 Civil Rights Act to charge the agency with racial discrimination in its permitting process. In late 1997, a federal judge ruled that the suit, the first federal court case of its kind, could proceed. Recent action by the EPA has aimed at ensuring that states and other recipients of federal funds do not discriminate in siting decisions.

Environmental justice workers note that waste disposal facilities can have detrimental effects on local economic growth. Robert Bullard, director of the Environmental Justice Resource Center at Georgia's Clark Atlanta University, noted in the same issue of *E* that a locality with one waste disposal facility tends to attract others and can unintentionally discourage "cleaner" industries. Thus, a landfill could restrict a county's economic prospects without providing offsetting advantages. "Most of these facilities don't even hire people that live in the community," asserts Bullard. For broad economic growth and environmental health, therefore, local governments should approach siting decisions carefully, should have a plan for directing revenue to meet local needs, and should inform citizens of the long-term environmental plan.

New Technologies

One topic that has received scant attention in the landfill debate is a new technical option, the bioreactor landfill. Bioreactor landfills use microbiological processes to accelerate waste decomposition. By adding moisture and recycling leachate into the fill, bioreactors can break down organic waste in

just 5–10 years. This means that waste settles faster and the amount of leachate produced is less than for standard landfills, where decomposition continues to produce leachate for many decades after closure. In general, bioreactors hold greater potential for drier regions, where the decomposition rate of standard landfills is especially low. They may, however, also pose a greater challenge in those areas, as moisture for adding to the bioreactor is scarcer.

Debra Reinhart, the associate dean of engineering at the University of Central Florida in Orlando and author of the book *Landfill Bioreactor Design and Operation*, says there is growing interest in this new technology. "I get a lot of calls asking for information on bioreactors," she says, "and not just in the United States but from all over the world."

Part of the interest lies in the fact that bioreactors can offer economic advantages to landfill owners. The faster decomposition process of bioreactors can increase a landfill's capacity while it is active. And because bioreactor landfills require shorter periods for stabilization (the cessation of gas production under normal operating conditions), the long-term costs of monitoring closed fills can be reduced by 15–20 years after it's closed, according to Reinhart. Several economic analyses of bioreactors have suggested very positive economic returns. In some cases, bioreactors can even provide energy for nearby communities. According to Garcia, the Settler's Hill bioreactor landfill located in Kane County, Illinois, includes a gas recovery facility that generates energy to service approximately 10,000 neighboring households.

Not everyone is convinced that bioreactors are the answer, though. According to Lee, bioreactors don't adequately address the risk of groundwater pollution. Most MSW is not shredded because it is expensive to do so, he says. The unshredded waste remains trapped in plastic garbage bags, beyond the reach of the leachate that is circulated in bioreactors to speed decomposition, and thus will remain in the fill with the potential to leak.

Also, bioreactors, like conventional landfills, produce odors. Because odor is a potential problem, Reinhart says, it is important to collect gas quickly and efficiently. A bioreactor she is working on in central Florida will initially burn the gas in flares and may eventually generate energy for nearby use. Bioreactors may also require more training for landfill operators because recirculating the leachate through the bioreactor and monitoring the decomposition process involves more scientific understanding than the loading and sealing of traditional landfills.

Despite recycling efforts, the need for waste disposal continues to grow. Landfill technology is changing quickly, and these changes will require better education for better public decisions. Virginia's recent experience shows that, although landfill safety technology has made great strides in the past two decades, gaps remain in understanding the actual health risks and economic mechanisms behind the new interstate trade it has created.

David Taylor